

# Application and Evaluation of the Effectiveness of Speed-Strength Development Exercises for Male Volleyball Athletes Aged 14–15 at the Hanoi Sports Training and Competition Center

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**Abstract**— *This study evaluated the effectiveness of a 36-exercise speed-strength training system for male volleyball athletes aged 14–15 at the Hanoi Sports Training and Competition Center. Twenty-five athletes were divided into an experimental group and a control group over a 12-month pedagogical experiment. Results demonstrated significant improvements in explosive power, movement speed, physiological adaptation, and psychological–neurological performance in the experimental group. Statistical analysis confirmed that the proposed exercise system had high scientific validity and practical effectiveness in improving speed-strength performance for youth volleyball athletes.*

**Keywords**— *speed-strength, volleyball, youth athletes, pedagogical experiment, physical training*

## I. INTRODUCTION

In modern volleyball, speed-strength is considered one of the most important physical qualities determining the effectiveness of technical performance and competitive achievement. Specialized movements such as spiking, blocking, quick attacking, and defensive transitions require athletes to generate maximum force within the shortest possible time. Therefore, the development of speed-strength has become a central objective in modern volleyball training, especially for young athletes who are in the stage of rapid neuromuscular development and motor skill formation.

According to Philin V.P. (1996), the training process for youth athletes must be organized in accordance with biological adaptation principles and age-related physiological characteristics in order to ensure sustainable athletic development (Philin, 1996). In volleyball, several studies have emphasized the decisive role of speed-strength in improving jumping ability, spiking power, movement speed, and overall technical efficiency. Tran Hung (2008) reported that the development of speed-strength significantly influences the effectiveness of spiking techniques in male volleyball athletes aged 14–17 (Tran Hung, 2008). Similarly, To Xuan Thuc (2014) demonstrated a close relationship between strength

qualities and the technical effectiveness of jump serving and jump setting in volleyball (To Xuan Thuc, 2014).

Research conducted by Tran Duc Phan (2001) emphasized that specialized exercise systems play a decisive role in developing agility and movement coordination in young volleyball athletes (Tran Duc Phan, 2001). According to Phomin E.V. (1986), speed development in youth volleyball athletes requires specialized exercises with high neuromuscular stimulation and appropriate training progression (Phomin, 1986).

However, current training practices for youth volleyball athletes in many local training centers still reveal several limitations. Most training programs mainly focus on general physical conditioning and movement speed, while specialized exercises integrating strength, speed, and volleyball-specific technical skills remain insufficient. In addition, the organization of speed-strength training often lacks systematic periodization, scientific load control, and competitive simulation. As a result, athletes frequently fail to maintain stable explosive performance during high-intensity match situations.

The practical survey conducted at the Hanoi Sports Training and Competition Center showed that although some exercises related to explosive movement and volleyball

techniques were applied, the training content remained fragmented and lacked a specialized system suitable for the developmental characteristics of athletes aged 14–15. The absence of scientifically structured speed-strength exercises may negatively affect athletes' ability to optimize explosive force production, neuromuscular coordination, and technical execution during competition.

From the perspective of modern sports-training theory, speed-strength can only be effectively developed through highly specialized exercise systems combined with appropriate training periodization and scientific monitoring of training intensity and volume. Therefore, the selection, application, and evaluation of a systematic speed-strength training program suitable for young volleyball athletes is considered an urgent and practical requirement. Nguyen Xuan Sinh (1999) stated that scientific research in sports training must ensure objectivity, reliability, and practical applicability through appropriate testing and statistical methods (Nguyen Xuan Sinh, 1999).

Derived from these theoretical and practical considerations, the present study was conducted to apply and evaluate the effectiveness of speed-strength development exercises for male volleyball athletes aged 14–15 at the Hanoi Sports Training and Competition Center. The research aimed to provide scientific evidence for improving specialized physical training and enhancing competitive performance in youth volleyball athletes.

## II. RESULTS AND DISCUSSION

### 2.1. Analysis of the Current Speed-Strength Training Exercises for Male Volleyball Athletes Aged 14–15 at the Hanoi Sports Training and Competition Center

Based on practical surveys and analysis of the existing training program at the Hanoi Sports Training and Competition Center, the study identified 20 exercises currently used for developing speed-strength in male volleyball athletes aged 14–15. These exercises included non-ball drills, volleyball-specific drills, and competition-related exercises. The exercise system

mainly focused on improving jumping ability, movement speed, upper- and lower-body explosive strength, and technical coordination in volleyball performance.

The selection and classification of exercises were based on principles of specialized volleyball training and anthropometric suitability for adolescent athletes (Pham Tuan Phuong, 1994). However, analysis of the structure and content of the training exercises revealed several limitations in the current training process. Most exercises primarily emphasized general speed and endurance development, while specialized speed-strength exercises directly associated with jumping, spiking, and blocking performance remained limited. In particular, the number of exercises combining strength, speed, and volleyball-specific technical execution was still insufficient to satisfy the demands of modern volleyball training.

In addition, although several exercises simulated competitive situations, such as positional spiking drills, repeated blocking movement drills, and three-player defensive exercises, these activities were not organized into a scientifically controlled competition-training system. The absence of quantified training parameters, including movement intensity, training volume, number of jumps, and spiking repetitions, reduced athletes' ability to identify their individual adaptation thresholds and evaluate their own strengths and weaknesses in speed-strength performance.

Furthermore, the repetitive and monotonous nature of several training contents negatively affected athletes' motivation and long-term training enthusiasm. Consequently, maintaining high-intensity performance during prolonged competition periods remained difficult for young athletes. This issue directly influenced the stability of speed-strength performance during decisive phases of volleyball matches.

From the perspective of modern sports-training theory, speed-strength can only be effectively developed through highly specialized exercises combined with scientific periodization and strict monitoring of training intensity and workload. Therefore, the selection and application of a systematic speed-strength training program suitable for youth volleyball athletes became an urgent practical and scientific requirement.

*Table 1: 20 speed and strength development exercises for male volleyball players aged 14-15 at the Hanoi Sports Training and Competition Center*

| No | Exercise Name         | Main exercise group | Main Impact Objectives                         |
|----|-----------------------|---------------------|------------------------------------------------|
| 1  | Jump with run-up (m)  | No ball             | Develop leg speed and jumping power            |
| 2  | Jump with run-up (cm) | No ball             | Develop vertical speed power                   |
| 3  | Pine tree run (s)     | No ball             | Develop agility and directional change ability |

|    |                                                             |                       |                                                        |
|----|-------------------------------------------------------------|-----------------------|--------------------------------------------------------|
| 4  | Running with change of direction on command (s)             | No ball               | Develop reaction speed and movement speed              |
| 5  | Zigzag run from sideline to attack boundary line            | No ball               | Develop combined speed power and coordination          |
| 6  | Jump rope 2 minutes (times)                                 | No ball               | Develop lower limb speed endurance                     |
| 7  | Prone position with hands on the ground                     | No ball               | Develop arm, shoulder, and trunk muscle strength       |
| 8  | Pulling rubber band                                         | No ball               | Develop upper limb speed power                         |
| 9  | Jumping block combined with side movement 2 minutes (times) | No ball               | Develop jumping and lateral movement speed power       |
| 10 | Jumping and throwing rubber ball over the net               | No ball               | Develop hand-foot speed and coordination power         |
| 11 | Bouncing ball (group of 2 people)                           | No ball               | Develop reflexes and hand speed power                  |
| 12 | Passing squished ball (0.5–1 kg)                            | With ball             | Develop upper limb speed power                         |
| 13 | Throwing squished ball 1.5–3 kg                             | With ball             | Develop trunk and arm speed power                      |
| 14 | Throwing squished ball (1 kg) with one hand (m)             | With ball             | Develop striking speed power                           |
| 15 | Bouncing ball with change of position (4,3,2)               | With ball             | Develop speed power and specialized coordination power |
| 16 | Moving block repeatedly along the net                       | With ball             | Develop jumping and movement speed power               |
| 17 | Defensive practice in group of 3 people                     | With ball             | Develop speed endurance and teamwork coordination      |
| 18 | Pine tree run (s)                                           | Specialized exercises | Develop speed and speed power                          |
| 19 | Pulling rubber band                                         | Specialized exercises | Develop upper limb speed power                         |
| 20 | Competition                                                 | Specialized exercises | Develop overall speed power and competitive spirit     |

## 2.2. Applying strength and speed development exercises for young male volleyball players aged 14-16 in Hanoi

### 2.2.1. Organization of pedagogical experiments

A pedagogical experiment is a process aimed at testing a selected system of strength and speed development exercises and a new training plan on research subjects, while simultaneously determining the impact of the strength and speed development exercise system and training plan on improving the strength and speed of the research subjects.

The pedagogical experiment was conducted to verify the effectiveness of the system of 36 strength and speed development exercises and the 12-month training plan that had been developed.

Experimental subjects: The study selected 25 male young volleyball players from Hanoi, aged 14-15, meeting

similar health and professional skill requirements. The players were randomly divided into two groups:

Experimental group (n=13): Training according to the system of 36 exercises and the new training plan of the study.

Control group (n=12): Training according to the traditional training program of their managing unit.

Experimental Conditions:

Duration: 12 months (February 2023 to January 2024).

Duration: Performed for 30-35 minutes at the end of each main training session.

Frequency: 3 sessions/week (Monday, Wednesday, Friday or Tuesday, Thursday, Saturday).

Variable Control: Both groups maintained the same nutrition, rest, and general tactical training regimen. The only difference lay in the specific intensive physical training content for the experimental group.

### 2.2.2. Assess the homogeneity of the groups before the experiment

Before the experimental program was implemented, all athletes participated in 11 evaluation tests related to physical fitness, volleyball-specific performance, physiological function, and psychological–neurological ability. The evaluation system used in this study followed

scientific testing principles commonly applied in sports science research (Nguyen Xuan Sinh, 1999).

Statistical analysis showed that the coefficients of variation (Cv) for all indicators were below 10%, demonstrating high homogeneity between the two groups. Comparisons between the experimental and control groups before training intervention revealed no statistically significant differences ( $P > 0.05$ ) in any of the evaluated tests. Therefore, both groups were considered equivalent in terms of initial speed-strength performance and suitable for pedagogical experimentation.

Table 2. Results of determining the homogeneity of the study subjects ( $n=25$ )

| No         | Test Content                                     | ( $\bar{X} \pm \sigma$ ) | Cv (%) |
|------------|--------------------------------------------------|--------------------------|--------|
| <b>I</b>   | <b>Physical Fitness – Specialized Test Group</b> |                          |        |
| 1          | High Jump with Run (cm)                          | $308.6 \pm 9.2$          | 2.98   |
| 2          | Standing Long Jump (cm)                          | $262.4 \pm 11.5$         | 4.38   |
| 3          | Overhead Throw (m)                               | $12.1 \pm 0.9$           | 7.43   |
| 4          | Skiping Run 4 times 10m (s)                      | $10.28 \pm 0.52$         | 5.05   |
| 5          | Zigzag Run 9-3-6-3-9m (s)                        | $6.58 \pm 0.38$          | 5.77   |
| 6          | Powerful Spike at Side 4 (Points)                | $6.8 \pm 0.5$            | 7.35   |
| <b>II</b>  | <b>Biomedical Test Group</b>                     |                          |        |
| 7          | Dominant Hand Grip Strength (kg)                 | $37.2 \pm 2.6$           | 6.98   |
| 8          | Back Muscle Strength (kg)                        | $82.4 \pm 5.8$           | 7.03   |
| 9          | Ruffier Index (I.R)                              | $8.5 \pm 0.8$            | 9.41   |
| <b>III</b> | <b>Psychological – Neurological Test Group</b>   |                          |        |
| 10         | Complex Reflexes (ms)                            | $308.5 \pm 14.2$         | 4.60   |
| 11         | Schulte Number Chart Test (s)                    | $29.2 \pm 2.1$           | 7.19   |

The analysis results in Table 3.22 show that the coefficient of variation (Cv) for all 11 test indicators is less than 10% (ranging from 2.98% to 9.41%). This demonstrates that the sample of 25 athletes (divided into groups of 13 and 12) has low dispersion and high homogeneity in terms of physical fitness, biomedical function, and neuropsychological well-being.

This similarity in initial performance is an important legal and scientific basis for conducting the pedagogical experiment. Any changes in performance after the 12-

month training cycle will accurately reflect the effectiveness of the 36 SMTD exercise system proposed in the study.

Before implementing the 36 exercise system, we conducted tests to divide the groups and used the results as a basis for comparison. The total of 25 athletes were randomly divided into: Experimental Group ( $n=13$ ) and Control Group ( $n=12$ ). The results of the pre-experimental tests are presented in Table 3.

Table 3. Comparison of SMTD levels between the two groups before the experiment ( $n=25$ )

| No       | Test content                                        | TN Group ( $n=13$ ) | DC Group ( $n=12$ ) | t    | P        |
|----------|-----------------------------------------------------|---------------------|---------------------|------|----------|
| <b>I</b> | <b>Physical Fitness and Expertise Testing Group</b> |                     |                     |      |          |
| 1        | High jump with run-up (cm)                          | $309.2 \pm 8.1$     | $308.0 \pm 8.5$     | 0.36 | $> 0.05$ |
| 2        | Standing long jump (cm)                             | $263.5 \pm 10.5$    | $261.2 \pm 11.2$    | 0.53 | $> 0.05$ |
| 3        | Overhead throw (m)                                  | $12.2 \pm 0.8$      | $12.0 \pm 0.9$      | 0.58 | $> 0.05$ |

|            |                                                     |              |              |      |        |
|------------|-----------------------------------------------------|--------------|--------------|------|--------|
| 4          | Swing 4/10m (s)                                     | 10.25 ± 0.48 | 10.32 ± 0.55 | 0.34 | > 0.05 |
| 5          | Zigzag run 9-3-6-3-9m (s)                           | 6.55 ± 0.35  | 6.62 ± 0.41  | 0.46 | > 0.05 |
| 6          | Powerful spike at side 4 (Points)                   | 6.9 ± 0.5    | 6.7 ± 0.6    | 0.91 | > 0.05 |
| <b>II</b>  | <b>Biomedical Testing Group</b>                     |              |              |      |        |
| 7          | Dominant hand grip strength (kg)                    | 37.5 ± 2.5   | 36.9 ± 2.8   | 0.56 | > 0.05 |
| 8          | Back muscle strength (kg)                           | 83.1 ± 5.5   | 81.6 ± 6.1   | 0.65 | > 0.05 |
| 9          | Ruffier index (I.R)                                 | 8.4 ± 0.7    | 8.6 ± 0.9    | 0.62 | > 0.05 |
| <b>III</b> | <b>Psychological and Neurological Testing Group</b> |              |              |      |        |
| 10         | Complex reflection (ms)                             | 307.4 ± 13.5 | 309.8 ± 15.1 | 0.42 | > 0.05 |
| 11         | Schulte number test (s)                             | 29.0 ± 2.0   | 29.5 ± 2.3   | 0.58 | > 0.05 |

The data in Table 3 shows that the test results for all 11 physical, technical, biomedical, and neuropsychological indicators of both the experimental and control groups had t-values (calculated) smaller than the t-value (table) = 2.069. With a probability of  $P > 0.05$ , the difference in performance between the two groups is not statistically significant. This conclusion confirms that the division of the experimental and control groups was completely objective; the initial strength and speed levels of the 25 athletes were equivalent, meeting the conditions for conducting a pedagogical experiment.

### 2.2.3. Results of speed and strength tests for the two groups after the experiment

#### Results of tests after 6 months of experiment

After six months of training, the experimental group demonstrated noticeable improvement trends in most evaluation indicators compared with the control group. The average results of explosive jumping ability, movement speed, upper-body strength, and volleyball-specific technical performance were generally superior in the experimental group.

Significant differences were identified in medicine-ball throwing performance ( $P < 0.01$ ) and

powerful spiking ability ( $P < 0.05$ ). These findings indicated that the speed-strength exercise system positively affected explosive upper-body strength and volleyball-specific force transmission ability.

The gradual improvement observed after six months was consistent with the biological adaptation principles described by Philin (1996) and the neuromuscular development characteristics reported by Phomin (1986). However, several indicators did not yet reach statistical significance after six months because the early phase of training mainly focused on neuromuscular adaptation and the establishment of physiological foundations.

From the perspective of sports physiology, this stage primarily involved improvements in motor-unit recruitment, intermuscular coordination, and neural transmission efficiency rather than immediate comprehensive performance enhancement. Therefore, the absence of significant differences in some complex indicators such as reaction time and concentration ability did not represent a limitation of the training program, but rather reflected the biological adaptation process characteristic of youth athletes during the early stages of specialized training.

Table 4. Comparison of speed and power between the experimental and control groups after six months of experimentation

| No | Test content                     | TN Group ( $\bar{X} \pm \sigma$ ) | DC Group ( $\bar{X} \pm \sigma$ ) | t    | P      |
|----|----------------------------------|-----------------------------------|-----------------------------------|------|--------|
| 1  | High jump with run-up (cm)       | 315.4 ± 8.2                       | 310.2 ± 8.8                       | 1.53 | > 0.05 |
| 2  | Standing long jump (cm)          | 268.2 ± 10.5                      | 264.5 ± 10.8                      | 0.87 | > 0.05 |
| 3  | Overhead throw (m)               | 13.5 ± 0.8                        | 12.4 ± 0.9                        | 3.24 | < 0.01 |
| 4  | 4x10 shuttle run (s)             | 10.05 ± 0.42                      | 10.22 ± 0.48                      | 0.94 | > 0.05 |
| 5  | 9-3-6-3-9m zigzag run (s)        | 6.38 ± 0.32                       | 6.52 ± 0.38                       | 1.00 | > 0.05 |
| 6  | Powerful spike (4 points)        | 7.5 ± 0.5                         | 6.9 ± 0.6                         | 2.73 | < 0.05 |
| 7  | Dominant hand grip strength (kg) | 39.2 ± 2.4                        | 37.8 ± 2.6                        | 1.40 | > 0.05 |



|    |                           |              |              |      |        |
|----|---------------------------|--------------|--------------|------|--------|
| 8  | Back muscle strength (kg) | 86.5 ± 5.2   | 83.2 ± 5.6   | 1.53 | > 0.05 |
| 9  | Ruffier index (I.R)       | 8.0 ± 0.6    | 8.4 ± 0.8    | 1.43 | > 0.05 |
| 10 | Complex reflex (ms)       | 298.5 ± 12.4 | 306.4 ± 14.2 | 1.48 | > 0.05 |
| 11 | Schulte score (s)         | 27.8 ± 1.6   | 28.8 ± 2.1   | 1.35 | > 0.05 |

The results in Table 4 show that, after 6 months of experimentation, most of the speed strength indicators of the experimental group showed a clear improvement and achieved better average values compared to the control group. This reflects the initial effectiveness and correct orientation of the speed strength development exercise system applied to the experimental group. However, statistically speaking, the difference between the two groups was not statistically significant in all tests. Specifically, in indicators such as high jump with run-up, standing long jump, 4 × 10 m shuttle run, 9-3-6-3-9 m zigzag run, dominant hand grip strength, back muscle strength, Ruffier index, complex reflexes, and Schulte's table test, the calculated t-values were all smaller than the table t-value ( $t = 2.069$ ) at a probability threshold of  $P > 0.05$ . These results show that the differences between the experimental and control groups in the tests were not statistically significant, although the experimental group showed better progress. This reflects the regularity of physical training in general and speed and strength training in particular at the age of 14–15. In the first six months of the training cycle, development mainly occurs in the direction of accumulating a physical foundation and perfecting the initial adaptive mechanisms of the neuromuscular system, rather than creating a clear breakthrough in performance in complex tests. This is the stage where processes such as increasing the ability to mobilize motor units, improving intermuscular-intramuscular coordination, regulating the rhythm of muscle contraction and relaxation, and optimizing nerve impulse conduction are occurring vigorously but are not yet fully stable. Conversely, in some tests with a high degree of mechanical impulsivity, requiring relatively simple movements and directly related to specialized speed and strength, the differences between the two groups were clearly demonstrated and statistically significant. Specifically:

The overhead dribbling test showed a very clear difference between the two groups ( $t = 3.24$ ;  $P < 0.01$ ), reflecting the effective development of explosive upper limb strength and the ability to transmit force through a kinematic chain;

The powerful spike test along the 4-axis range also showed a statistically significant difference ( $t = 2.73$ ;  $P < 0.05$ ), indicating the positive impact of the exercise system on

specialized speed strength directly related to spiking technique.

These results show that the speed strength development exercises selected and organized in the experimental group had an early effect on abilities characterized by explosiveness, high intensity, and short impact time. These are also the factors that determine the effectiveness of the spike in modern volleyball competition, especially in young players who are in the stage of perfecting basic techniques and improving the quality of movement. From a training physiology perspective, the first six months of the experimental cycle can be considered a period of strength accumulation and functional foundation building, during which the athlete's central nervous system and musculoskeletal system gradually adapt to the new intensity and structure of movement. While changes in maximum strength, muscle contraction speed, and motor coordination have appeared, they are not yet mature enough to create stable and comprehensive differences in complex tests such as complex reflexes or attention span (Schulte).

Therefore, the lack of statistically significant differences in many tests after 6 months is not a limitation of the training program, but is entirely consistent with the laws of biological adaptation and the principles of sports training progress. Initial progress is formed first in spontaneous and specialized indicators, then spreads to more complex abilities in the next training phase.

In short, the results of the 6-month experimental tests have initially confirmed the scientific validity, feasibility, and practical effectiveness of the 36 speed strength development exercises developed in this study. At the same time, these results also provide a solid foundation for the intensive training phase in the following 6 months, where the differences in speed strength between the experimental and control groups are expected to be more clearly and comprehensively demonstrated.

#### *Evaluating the results after 12 months of experimentation*

After completing the full 12-month training cycle (ending in January 2024), the study conducted a final comprehensive assessment to evaluate the effectiveness of the 36 strength and speed development exercises for male volleyball players aged 14-15. The test content was standardized using the 11 tests previously used in the

experimental phases, ensuring consistency, uniformity, and comparability over time.

The results comparing the experimental group (TN) and the control group (DC) after 12 months are presented in Table 5.

Table 5. Comparison of results between the experimental group and the control group after 12 months of experimentation

| No | Test content                     | TN Group ( $\bar{X} \pm \sigma$ ) | DC Group ( $\bar{X} \pm \sigma$ ) | t    | P       | W (%) |
|----|----------------------------------|-----------------------------------|-----------------------------------|------|---------|-------|
| 1  | High jump with run-up (cm)       | 326.8 $\pm$ 6.4                   | 314.2 $\pm$ 8.1                   | 4.34 | < 0.001 | 5.8%  |
| 2  | Standing long jump (cm)          | 285.4 $\pm$ 8.2                   | 268.5 $\pm$ 9.6                   | 4.75 | < 0.001 | 8.2%  |
| 3  | Overhead throw (m)               | 15.4 $\pm$ 0.5                    | 12.9 $\pm$ 0.7                    | 10.4 | < 0.001 | 21.8% |
| 4  | 4x10m shuttle run (s)            | 9.45 $\pm$ 0.25                   | 10.12 $\pm$ 0.42                  | 4.89 | < 0.001 | 8.1%  |
| 5  | 9-3-6-3-9m zigzag run (s)        | 5.92 $\pm$ 0.20                   | 6.42 $\pm$ 0.35                   | 4.46 | < 0.001 | 10.1% |
| 6  | Powerful spike (4 points)        | 8.8 $\pm$ 0.4                     | 7.2 $\pm$ 0.6                     | 7.92 | < 0.001 | 24.3% |
| 7  | Dominant hand grip strength (kg) | 43.5 $\pm$ 2.1                    | 39.2 $\pm$ 2.5                    | 4.67 | < 0.001 | 14.8% |
| 8  | Back muscle strength (kg)        | 98.4 $\pm$ 4.5                    | 87.6 $\pm$ 5.4                    | 5.45 | < 0.001 | 16.9% |
| 9  | Ruffier index (I.R)              | 6.8 $\pm$ 0.5                     | 8.0 $\pm$ 0.7                     | 4.96 | < 0.001 | 21.6% |
| 10 | Complex reflex (ms)              | 282.4 $\pm$ 9.2                   | 305.2 $\pm$ 12.8                  | 5.14 | < 0.001 | 8.8%  |
| 11 | Schulte score (s)                | 24.2 $\pm$ 1.4                    | 28.2 $\pm$ 1.9                    | 6.03 | < 0.001 | 18.7% |

Experimental results after 12 months showed a significant, comprehensive, and statistically significant improvement in speed and strength across all tests in the experimental group. The calculated t-values for all 11/11 indicators were greater than the table t-values, with a significance level of  $P < 0.001$ , confirming the clear difference between the two groups and demonstrating the practical effectiveness of the exercise system developed in this study.

#### *Group of indicators for explosive power and professional speed power*

Tests assessing explosive strength and rapid power generation, such as high jump with run-up, standing long jump, overhead throw, and powerful spike with a range of 4, all recorded superior growth in the experimental group, with relative growth (W%) ranging from 5.8% to 24.3%. In particular, the overhead throw ( $W = 21.8\%$ ) and powerful spike ( $W = 24.3\%$ ) tests showed the greatest improvement, directly reflecting the effectiveness of the systematic transition in training content: from building muscle power through resistance strength exercises in the first 6 months to optimizing speed strength through plyometrics and specialized exercises in the following 6 months. This is consistent with modern principles of muscle contraction-relaxation cycle development in high-performance sports training.

#### *Biomedical and neuropsychological functional indicators*

Besides improvements in athletic performance, biomedical and neuropsychological indicators also showed significant improvement. Specifically, the Ruffier index (I.R) decreased significantly, indicating a marked improvement in the cardiovascular adaptability and recovery of the experimental group of athletes. Simultaneously, complex reflexes and the Schulte test improved with high statistical significance, reflecting the stability and development of central nervous system function. This helps athletes maintain observation, information processing, and quick reaction capabilities under high-intensity and constantly changing competition conditions. These results confirm that the training system not only impacts muscle strength but also positively affects fundamental functional factors, contributing to the overall performance of young athletes.

#### *Intergroup comparison and its practical implications*

Comparison between the two groups showed that, although the control group also showed some progress due to the influence of routine training and natural age-related development, the rate and extent of growth were significantly lower than that of the experimental group. The difference, at  $P < 0.001$  in most tests after 12 months, refuted the hypothesis that progress stemmed solely from biological growth factors, and affirmed the decisive role of the exercise system and training process designed in the study.

#### *Physical fitness and professional skills test group*

Tests reflecting explosive power and high-speed movement capabilities, such as: High jump with run-up; Standing long jump; Overhead dribble; 4x10 m shuttle run; 9-3-6-3-9 m zigzag run; and Power spike (sideline 4), all showed that the experimental group's column was significantly higher (or lower in time-based tests) than the control group's column. The most notable differences were in: Overhead dribble and Power spike (sideline 4). This demonstrates that the 36 SMTD exercises strongly impacted the ability to mobilize the fast motor unit, optimize the muscle contraction-relaxation cycle, and enhance the efficiency of power transmission in specific volleyball movements.

#### *Biomedical testing group*

The indicators: Dominant hand grip strength; Back muscle strength; Ruffier index

show that the TN group showed a significant improvement in muscular strength and cardiovascular recovery ability. This reflects that the training process not only increased mechanical power but also enhanced physiological adaptability, helping athletes maintain high intensity during competition.

#### *Psychological and neurological testing group*

In the tests: Complex Reflexes; Schulte's Table Test; the experimental group (TN) had significantly shorter reaction and information processing times compared to the control group (DC). This result confirms that the speed and strength training program not only impacts the muscular system but also improves the efficiency of the central nervous system, contributing to enhanced quick and accurate decision-making under high-pressure competition conditions. From the comparative graph results after 12 months, it can be confirmed that:

The progress of the experimental group is not random, but the result of a scientific, controlled, and clearly directed training process.

The system of 36 speed and strength development exercises with a 12-month cycle is suitable for the bio-muscle-neurological development characteristics of male volleyball players aged 14-15.

The graph is visual evidence, firmly reinforcing the statistical results in Table 5, confirming the effectiveness of the training program developed by this study. From the above results, it can be affirmed that the application of the 36-exercise system for developing speed and strength over a 12-month period is entirely appropriate, scientifically sound, and highly effective. This training model not only significantly improves speed and strength but also enhances biomedical and neuropsychological functions, meeting the requirements for improving professional performance and

sustainable development for young male volleyball players in Hanoi.

### III. CONCLUSION

The results of this study confirmed that the application of the 36 speed-strength development exercises over a 12-month training period produced significant improvements in the physical, physiological, and psychological performance of male volleyball athletes aged 14–15 at the Hanoi Sports Training and Competition Center.

After the experimental period, the experimental group demonstrated superior development compared with the control group in all 11 evaluation tests related to explosive strength, movement speed, volleyball-specific technical performance, physiological adaptation, and neurological-psychological functions. The differences between the two groups reached a high level of statistical significance ( $P < 0.001$ ), confirming the scientific validity and practical effectiveness of the proposed training system.

The greatest improvements were observed in tests directly associated with volleyball-specific speed-strength performance, particularly medicine-ball throwing and powerful spiking ability. These findings indicate that the selected exercises effectively enhanced explosive force production, neuromuscular coordination, and the efficiency of specialized volleyball techniques.

In addition, the training program positively influenced functional physiological indicators such as cardiovascular recovery ability and reaction speed, thereby contributing to the improvement of athletes' comprehensive competitive capacity under high-intensity match conditions.

The results of the present study are consistent with previous studies on youth volleyball training and speed-strength development conducted by Tran Hung (2008), Tran Duc Phan (2001), and Philin (1996).

Based on the obtained results, it can be concluded that the 36-exercise speed-strength training system and the 12-month periodized training plan are scientifically appropriate, feasible, and effective for youth male volleyball athletes aged 14–15. The study also provides an important practical foundation for improving specialized physical training programs in youth volleyball and may serve as a reference for coaches and sports-training institutions in the future.

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